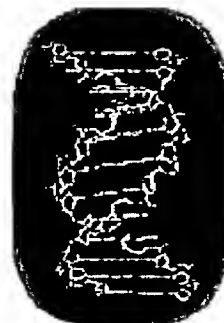


# The Genetic Code



		Second Position of Codon				
		T	C	A	G	
First Position	T	TTT Phe [F]	TCT Ser [S]	TAT Tyr [Y]	TGT Cys [C]	T
		TTC Phe [F]	TCC Ser [S]	TAC Tyr [Y]	TGC Cys [C]	C
		TTA Leu [L]	TCA Ser [S]	TAA <i>Ter</i> [end]	TGA <i>Ter</i> [end]	A
		TTG Leu [L]	TCG Ser [S]	TAG <i>Ter</i> [end]	TGG Trp [W]	G
	C	CTT Leu [L]	CCT Pro [P]	CAT His [H]	CGT Arg [R]	T
		CTC Leu [L]	CCC Pro [P]	CAC His [H]	CGC Arg [R]	C
		CTA Leu [L]	CCA Pro [P]	CAA Gln [Q]	CGA Arg [R]	A
		CTG Leu [L]	CCG Pro [P]	CAG Gln [Q]	CGG Arg [R]	G
	A	ATT Ile [I]	ACT Thr [T]	AAT Asn [N]	AGT Ser [S]	T
		ATC Ile [I]	ACC Thr [T]	AAC Asn [N]	AGC Ser [S]	C
		ATA Ile [I]	ACA Thr [T]	AAA Lys [K]	AGA Arg [R]	A
		ATG Met [M]	ACG Thr [T]	AAG Lys [K]	AGG Arg [R]	G
	G	GTT Val [V]	GCT Ala [A]	GAT Asp [D]	GGT Gly [G]	T
		GTC Val [V]	GCC Ala [A]	GAC Asp [D]	GGC Gly [G]	C
		GTA Val [V]	GCA Ala [A]	GAA Glu [E]	GGA Gly [G]	A
		GTG Val [V]	GCG Ala [A]	GAG Glu [E]	GGG Gly [G]	G

**An explanation of the Genetic Code:** DNA is a two-stranded molecule. Each strand is a polynucleotide composed of A (adenosine), T (thymidine), C (cytidine), and G (guanosine) residues polymerized by "dehydration" synthesis in linear chains with specific sequences. Each strand has polarity, such that the 5'-hydroxyl (or 5'-phospho) group of the first nucleotide begins the strand and the 3'-hydroxyl group of the final nucleotide ends the strand; accordingly, we say that this strand runs 5' to 3' ("*Five prime to three prime*"). It is also essential to know that the two strands of DNA run *antiparallel* such that one strand runs 5' -> 3' while the other one runs 3' -> 5'. At each nucleotide residue along the double-stranded DNA molecule, the nucleotides are complementary. That is, A forms two hydrogen-bonds with T; C forms three hydrogen bonds with G. In most cases the two-stranded, antiparallel, complementary DNA molecule folds to form a helical structure which resembles a spiral staircase. This is the reason why DNA has been referred to as the "Double Helix".

One strand of DNA holds the information that codes for various genes; this strand is often called the template strand or antisense strand (containing anticodons). The other, and complementary, strand is called the coding

strand or sense strand (containing codons). Since mRNA is made from the template strand, it has the same information as the coding strand. The table above refers to triplet nucleotide codons along the sequence of the coding or sense strand of DNA as it runs 5' -> 3'; the code for the mRNA would be identical but for the fact that RNA contains U (uridine) rather than T.

An example of two complementary strands of DNA would be:

(5' -> 3') **ATGGAATTCTCGCTC** (Coding, sense strand)  
 (3' <- 5') **TACCTTAAGAGCGAG** (Template, antisense strand)  
 (5' -> 3') **AUGGAAUUCUCGCUC** (mRNA made from Template strand)

Since amino acid residues of proteins are specified as triplet codons, the protein sequence made from the above example would be Met-Glu-Phe-Ser-Leu... (MEFSL...).

Practically, codons are "decoded" by transfer RNAs (tRNA) which interact with a ribosome-bound messenger RNA (mRNA) containing the coding sequence. There are 64 different tRNAs, each of which has an anticodon loop (used to recognize codons in the mRNA). 61 of these have a bound amino acyl residue; the appropriate "charged" tRNA binds to the respective next codon in the mRNA and the ribosome catalyzes the transfer of the amino acid from the tRNA to the growing (nascent) protein/polypeptide chain. The remaining 3 codons are used for "punctuation"; that is, they signal the termination (the end) of the growing polypeptide chain.

Lastly, the Genetic Code in the table above has also been called "The Universal Genetic Code". It is known as "universal", because it is used by all known organisms as a code for DNA, mRNA, and tRNA. The universality of the genetic code encompasses animals (including humans), plants, fungi, archaea, bacteria, and viruses. However, all rules have their exceptions, and such is the case with the Genetic Code; small variations in the code exist in mitochondria and certain microbes. Nonetheless, it should be emphasized that these variances represent only a small fraction of known cases, and that the Genetic Code applies quite broadly, certainly to all known nuclear genes.

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Suggestions for additions or changes can be sent to **Dr. Shaun D. Black**



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*Shaun D. Black, University of Texas Health Center at Tyler*

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